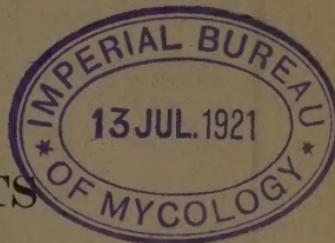


Z.W.P.
Flora W. Patterson

HATCH EXPERIMENT STATION

—OF THE—

MASSACHUSETTS



AGRICULTURAL COLLEGE.

BULLETIN NO. 61.

THE ASPARAGUS RUST IN MASSACHUSETTS.

APRIL, 1899.

The Bulletins of this Station will be sent free to all newspapers in the State and to such individuals interested in farming as may request the same.

AMHERST, MASS.:
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1899.

G.E. Stone + R.E. Smith

HATCH EXPERIMENT STATION

OF THE

Massachusetts Agricultural College, AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural, has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are:—

HENRY H. GOODELL, LL. D.,	<i>Director.</i>
WILLIAM P. BROOKS, PH. D.,	<i>Agriculturist.</i>
GEORGE E. STONE, PH. D.,	<i>Botanist.</i>
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HERBERT D. HEMENWAY, B. Sc.,	<i>Assistant Horticulturist.</i>
ARTHUR C. MONAHAN,	<i>Observer.</i>

The co-operation and assistance of farmers, fruit-growers, horticulturists, and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the

HATCH EXPERIMENT STATION, Amherst, Mass.

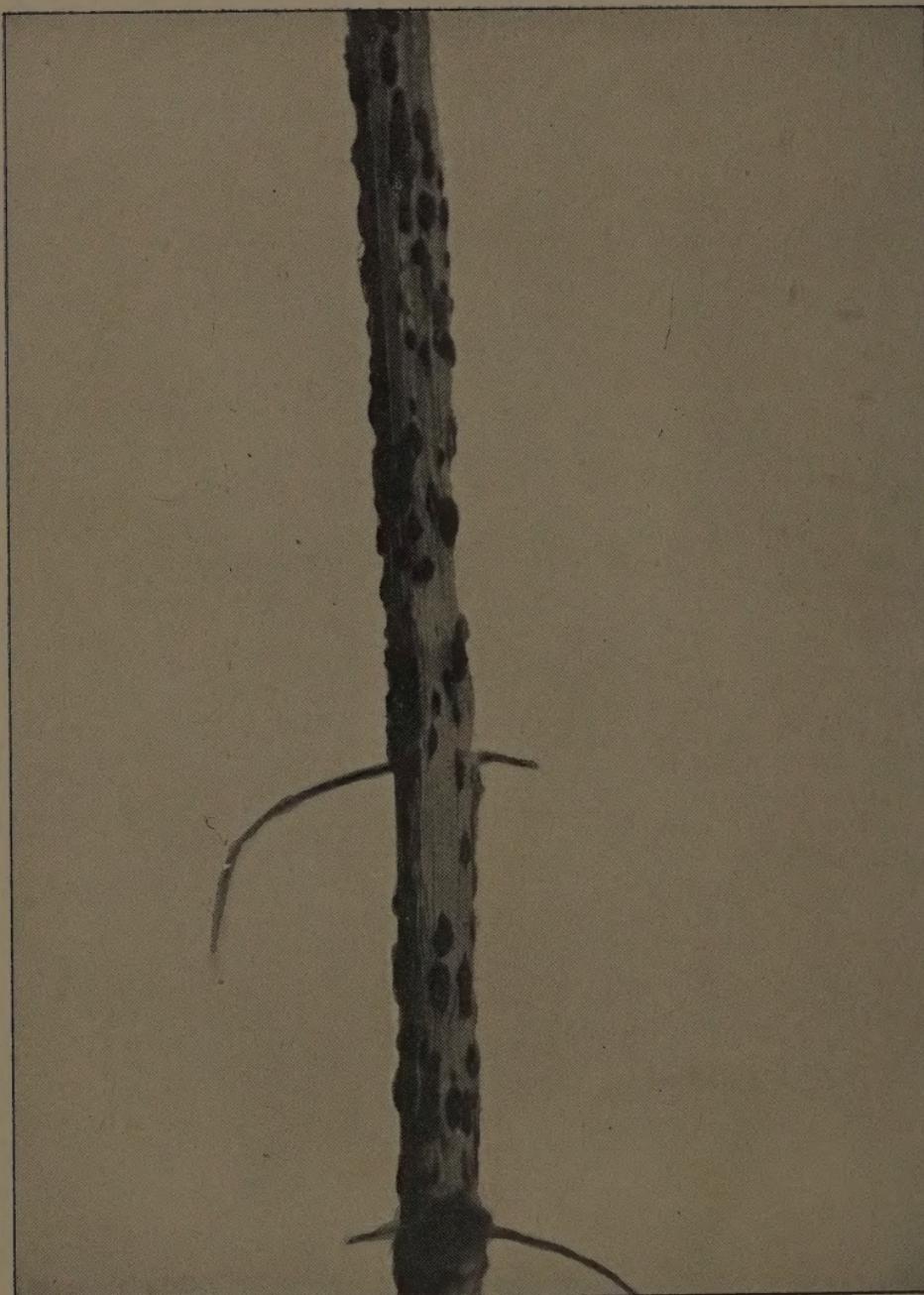


PLATE I.

BOTANICAL DIVISION.

G. E. STONE AND R. E. SMITH.

The Asparagus Rust in Massachusetts.

Various varieties of asparagus have been under cultivation for a great many centuries, and even as far back as the time of Pliny it is mentioned as being in the highest state of cultivation. It has been under cultivation in England and France for some hundred years, where it has been highly esteemed, and from which countries it was introduced into America by the early colonists. We find it occurring in Massachusetts at a very early period and Josselyn, in his "New England Rarities," published in 1672, says that "Sparagus thrives exceedingly." It is also known that the Huguenots, who settled at Oxford, Mass., in the year 1686, were skilled horticulturists and that they brought with them from their mother country, France, the best types of vegetables, fruits, and flowers, which they cultivated with a skill quite unknown to their English contemporaries. Among the various vegetables which they brought with them was the asparagus, and its plants after having been set out some two hundred years ago can at the present time be seen, or at least plants originating from the same stock, growing spontaneously year after year over the ruins of the original settlement of this remarkable people.

The cultivation of asparagus, however, was extremely limited in Massachusetts during the 17th and 18th centuries, it being confined to the private gardens of the more progressive and well-to-do families, and even at the beginning of the present century its cultivation was not at all common. As to that matter, it is probably within the bounds of accuracy when we affirm that even seventy-five years ago

the number of asparagus beds in a typical Massachusetts town would not exceed two or three. At the present time, however, this condition of affairs has been entirely changed and asparagus ranks as one of the most highly esteemed vegetables which go to the table. Asparagus beds are now found in every private garden of any pretence, and the production of this vegetable for the large markets in Massachusetts to-day utilizes many hundred acres of fertile land and provides occupation with fair returns to a large number of market-gardeners. According to some recent statistics pertaining to market-gardening in Massachusetts it is shown that the increase in the production of vegetables during the period from 1885 to 1895 has been 22%, and while there are no special data given concerning asparagus this product will undoubtedly rank among the first in its increase.

The growing of asparagus on a large scale in Massachusetts is confined to certain towns; it being most extensively grown in those possessing a light sandy soil. The largest growers are situated in the eastern sections of the state, near the large markets. In the vicinity of Concord there are some 400 acres of asparagus under cultivation which largely supply the Boston markets, and 100 acres or more are also controlled by the South Eastham Asparagus Co. on Cape Cod. The annual income from asparagus alone in Concord is estimated at \$100,000.

The Asparagus Rust.

The asparagus rust has been known in Europe for a great many years, and since the time of the elder de Candolle, who was the first to study it nearly a century ago, the rust has been known to be caused by a fungus which has borne the name *Puccinia Asparagi* D. C. It is known to occur in most of the countries of Europe and mention is made of it in all the principal publications on the continent relating to the diseases of plants. The first mention of the asparagus rust in the United States was by Harkness, who claimed to have observed it on the Pacific coast in 1880, although there appears to be some doubt whether the genuine rust, *Puccinia Asparagi*, was ever really found there. The first mention of it in the Eastern states was in the fall of 1896. Prof. Halsted was the first to call attention to it and we shortly afterwards observed it in this State on the beds at the Massachusetts Agricultural College. It

was learned at that time that it was distributed over New England, Long Island, New Jersey, and Delaware, where it had become firmly established, and the next year it had spread to the large asparagus beds in South Carolina, but so far as we are aware little if any but black spores (teleutospores) were noted in 1896 in Massachusetts, and no perceptible damage resulted to the marketable crop in 1897 as a result of the rust during 1896.

The fact, however, that the rust should appear over so large an area at practically the same time is rather astonishing, and if the infection started from a single point or even from distant places in this country, it is interesting as showing how quickly a fungus like this can spread over a large area in so short a time. There appears to be some doubt among practical growers in some localities in regard to the first appearance of the rust in 1896. We have recently learned from a number of different people residing on Cape Cod that it has been known there for some years, but it is impossible at the present time to procure absolute proof in regard to the reliability of this assertion. Some of the evidence in regard to these ideas may not be out of place here. One correspondent on the Cape writes as follows: "We have had the asparagus rust in this town for four or five years, but to no great extent until 1897;" and another gentleman from the same locality states that "The asparagus rust has been seen in this vicinity for a number of years," and that "Last year (1897) every one had it." The following from the Cape is along the same line. "I am confident that I have had the rust on my beds longer than 1896 * * * * and I feel certain that I had the disease two years before the growers in Concord." Or in other words as far back as 1894. At first we were strongly inclined to regard these ideas as mistaken ones, but as they appeared to be universal and strongly believed we became convinced that there might be some truth in them. Nevertheless it is not unlikely that in some instances certain other things have been mistaken for the rust or confused with it. It is well known that the young succulent stems of the asparagus as they are cut for the market frequently show reddish or rusty blotches upon their stems, and we have observed the same blotches upon the more mature plants just below the surface of the soil. These reddish blotches seem to occur upon plants grown in some soil more abundantly than upon others, and we are told that this is the reason why asparagus is not grown in

some localities. It is not unlikely that these blotches have been mistaken for the genuine rust. This view of the matter appears to have some support in the statement which we have received; namely, that the asparagus rust has been observed by one grower as occurring as early as April and May, which is quite contrary to all of our observations and to those of growers throughout the State. It is quite possible that this observer had in mind the rusty appearance of the stems, which so far as we are aware has no connection with the genuine rust.

Notwithstanding this however, it does not necessarily prove that the genuine rust did not exist here previous to 1896, inasmuch as it would be quite natural for one who saw the rust the first time to associate everything with it which resembled it. The impression is so strong among certain growers on the Cape that the rust existed there before 1896 that we are inclined to believe that this assertion is true, as it would seem to account more satisfactorily for the sudden outbreak in the middle states which occurred in 1896. The fierce and prolonged north-east winds and storms peculiar to that region could readily drive the rust spores in the direction of Long Island and New Jersey, where the rust when first discovered had secured a good foothold.

In 1897, the rust (uredospores) appeared early in some sections of this State and as a result of that summer's occurrence it completely incapacitated the asparagus plants—so far as the function of assimilation was concerned—which caused considerable alarm to asparagus growers. The date of the first appearance of the rust in 1897 as reported at Concord, Mass. was July 11th, and in the course of a few days the tops of the infected plants were completely brown. Few beds at Concord escaped the rust during the summer of 1897, and the injury resulting from it was quite marked. During the past season (1898) the rust did not make its appearance until September, in which instance the black spores (teleutospores) predominated. There is, however, one exception to this statement, and that is an instance where the rust (uredospores) appeared in July on a bed at Concord which was practically ruined in 1897, although none of the other beds in this locality during the same season showed any evidence of the red spores or summer stage, notwithstanding the fact that they were subject to infection. It should be stated, however, in connection with the rust, that in the majority of places in Massa-

chusetts it has never occurred during the summer, but on the other hand it is only the black spores (teleutospores) which have predominated, and these only making their appearance late in the season. While the statement holds good in regard to localities, it must be understood that it is not valid when we take into consideration the number and size of the asparagus beds which were affected. It unfortunately happened that the rust was most severe in those localities where asparagus is cultivated most extensively.

During the past season this division has made use of every opportunity to gather data concerning the rust, as well as to experiment upon control methods, and a number of days have been spent in looking over the various fields.*

Life History of the Asparagus Rust.

Puccinia Asparagi D. C.

The asparagus rust is caused by a fungus of the above name which is one of the true rusts or Uredineae. Like many other rusts, it appears in three different stages or forms of development. The first of these forms, called the *aecidial* or cluster cup shape, appears in early spring, but, since at that time the asparagus is being cut for market, the fungus is able to develop only upon such scattering stalks as are allowed to remain and grow up, and consequently is not at all noticeable at this season. Indeed we have never observed it in this state and know it only from the descriptions of Halsted† and others. In this stage the fungus produces little eruptions on the surface of the affected plants, each of which is a minute cavity in which numerous spores are developed in the form of long chains, which break up into separate roundish spores at maturity. These spores are carried by the wind to other plants and produce on them the second form of the rust.

SUMMER OR RED RUST STAGE. (UREDO.)

The rust is by far the most destructive in the red rust stage which appears in July and August. The plants in the main bed have been allowed to grow up by this time and if badly affected soon appear

*We wish here to acknowledge our indebtedness to Mr. C. W. Prescott and Mr. Wilfred Wheeler and especially to Mr. Thomas Hollis who extended to us every hospitality while at Concord.

†Bull. 129, New Jersey Agr'l Exp't Sta.

as if scorched by fire, having a dry and withered appearance and being of a reddish brown color. The fungus consists as usual of numerous fine filaments which grow through the tissue of the plant just beneath the surface, robbing it of its nourishment and thus interfering with its vital processes. Upon the surface appear numerous little blisters which soon burst open and discharge a reddish brown powdery substance, consisting of the red or *uredospores* of the fungus. These spores fly off as a cloud of fine dust when badly rusted plants are disturbed. They are carried in enormous quantities to all neighboring plants where they germinate and spread the disease.

THE FALL OR BLACK RUST STAGE. (TELEUTO.)

The third form of the rust appears in September and October on plants which have survived thus far. It is characterized by the appearance of small black excrescences upon the surface of the affected plants, which are clusters of the spores of this stage. These spores are very thick walled and thus suited to their function of surviving over winter. They remain dormant until spring when they proceed to germinate and reproduce the disease, now in the spring stage.

While this is the normal course of development of this fungus it is by no means certain that it is confined to such a course, and in fact circumstances seem to indicate that it is not. In the case of the closely related wheat rust, *Puccinia graminis* Pers., we know that it is able to pass the winter and reproduce itself again in the spring in at least four different ways, viz.: 1st, by the regular process of teleutospores lying over winter and producing aecidia in the spring; 2nd, by uredospores which survive the winter and produce the summer and fall forms in the succeeding season; 3rd, by teleutospores producing the summer stage directly without the intervention of the spring form; and 4th, by the fungus itself remaining alive in the tissues of plants and proceeding into growth again the next season. That the asparagus rust is able to reproduce itself from year to year in some or all of these ways in addition to its regular course of development seems extremely probable in view of the history of its occurrence in this State. We have, as already mentioned, never observed the spring form, and, while it may occur, we believe it to be extremely rare. The red rust form, as elsewhere

pointed out, has never been found in numerous places where the black rust came on later, or the two have appeared together in September when the tops had begun to ripen and die a natural death. This frequent appearance of the black, fall stage of the rust in places where no trace has been found of the two stages which should precede it, must, it seems to us, be explained in one of the following ways: Either the earlier stages did occur, but were not observed, these being quite scarce perhaps, or the spores came from a distance and produced the black rust, or, finally, the rust is able to skip over some of its stages as is the wheat rust. The first two of these suppositions cannot, of course, be absolutely contradicted, but, since careful and repeated examinations made of our bed here at the college during two summers failed to reveal any trace of the rust before Sept. 15th, we feel fully convinced that not a single particle of the spring or summer stage had developed. Furthermore, if the fungus can and does pass through its full course of development in all cases of its occurrence, that is if the spring and summer stages always occur before the fall stage can develop, there would seem to be no reason why they should not be abundant and common rather than exceptional. There were certainly enough teleutospores produced in the fall of 1897 to infect every plant in the State the following spring, but since such infection did not take place and the rust appeared in scarcely a single instance before the fall stage came on in September, the conclusion seems reasonable that one or more of the cases mentioned in connection with the wheat rust must have occurred. In beds where the teleutospores were produced in 1897, these spores, which evidently failed to infect the plants in the spring of 1898, may have retained their vitality until late summer and then have produced the rust in the fall stage, accompanied in some cases by a few belated uredospores. Another supposition is that the fungus remained alive over winter in the plant tissue, not producing spores again until September. This occurs in the wheat rust and several others. The hollyhock rust, (*Puccinia Malvacearum* Mont.) affords an instructive example in this connection. This rust produces only teleutospores. If an affected plant be brought into the hot house in midwinter and forced into growth, the rust will at once break out upon it, showing that the filaments of the fungus were still alive in the rootstock, and in the small, half evergreen leaves which are found in the hollyhock. The large fleshy root-

stock of the asparagus plant affords an excellent opportunity for a similar occurrence. We have in several instances found fungous filaments growing in young asparagus stems near the base and also in affected roots. We are not, however, prepared to say that they were those of *Puccinia Asparagi* or that they were not those of some other fungus having no connection with the rust whatever. It is at any rate an interesting question whether the asparagus rust cannot in this way become perennial and approach a life history closely resembling that of *Puccinia Malvacearum*.

We allude in discussing "The probable cause of the severe outbreak of the rust," to the reasons why the earlier stages of the fungus are so infrequent. It is apparently the ability of the healthy and vigorous plant to resist infection by the rust which confines its appearance to late summer and fall when the part of the plant above ground is beginning to lose its vitality by the normal process of approaching death. Thus, though unable to follow its complete course of development, the fungus manages to adapt itself to circumstances sufficiently to reproduce itself from year to year, and goes on, or will go on as long as possible, awaiting the opportunity for its complete development which a season unfavorable to the growth of the plants would give.

Amount of Damage Caused by the Rust.

The economic importance of asparagus is such that a serious malady affecting it means a great loss to those market-gardeners making it a specialty. Heretofore it has generally been acknowledged that the asparagus plants in this country have been particularly free from fungous diseases, although they have been more or less subject to the ravages of insects. The fact that the asparagus plant can persistently exist for two hundred years in an isolated neglected spot such as we have already alluded to is an excellent indication of its hardiness and adaptation to our climate. The rust in this State having been most severe in 1897, the damage to the crop would naturally be felt the most during the past season (1898). It should be stated here, however, that no perceptible damage has occurred to the asparagus in those localities where only the fall outbreak has occurred, which, with some few exceptions, is the only manner in which the rust has manifested itself in Massachusetts up to the present time. This stage of the rust, (teleutospore stage),

makes its appearance so late that it cannot affect appreciably the assimilating processes of the plant, and its appearance at this season of the year is largely a secondary affair connected with the natural dying of the tops.

When plants are affected in a similar way with the red spores (uredospores), the effect upon the plant during the following season is quite marked. As a rule asparagus growers in this section stop cutting for the market about the 1st of July, and by the middle of July, when the summer stage generally first commences to show itself, the tops are not fully grown, and it is only a matter of a few days before they are completely covered with red pustules, which give the plants a burned appearance and make them of little further use as assimilative organs. It does not require very much intelligence to comprehend the fact that if the plant's assimilating organs are incapacitated during the two most important months in the year, viz. July and August, there will be a lack of reserve material in the roots for the succeeding year's crop. Such, in fact, has been the condition of those plants which suffered from the effect of the rust during July and August of last year. The loss, however, as might be expected has been variable, bearing a direct relation to the severity of the attack. In the town of Concord, where we have been able to get reliable data concerning the amount of asparagus cut in the year '98, and that cut last year ('97), we have found that the loss experienced by different growers varies from 15 to 80 per cent. The bed which showed a loss of 80 per cent had hardly a sound root remaining last year as a result of the severe attack during 1897. Asparagus growers on the Cape have also experienced a loss of 20 to 25 per cent as a result of the rust. The lateness of the 1898 season would appear to account for some of this, but even when this is deducted there was probably not far from 20 per cent loss due to the rust alone. Generally, however, it might be stated that the loss experienced was something like 20 to 25 per cent.

There is still another source of loss to asparagus growers which is more important than that represented by the mere falling off of a single year's crop. We refer to the great injury which the roots received on account of the rust. We have observed many beds in which large numbers of roots were nearly dead, and, as they are not likely to recover from this effect, the loss from this source will not be replaced until new plants are set out and matured.

We have noticed that many of these affected roots show a tendency to throw up small insignificant shoots as if they were endeavoring to recover, but this recovery is more apparent than real, and it would be the wisest policy for growers to dig them up and replace them with new plants.

The Probable Cause of the Severe Outbreak.

In considering the asparagus rust in the U. S. it is not only proper to pay some attention to the source of contagion, but to the cause of the severe outbreak. We have already alluded to the fact that the rust has been known in Europe for many years, and that it was introduced from that country into the U. S., and although the rust was first noticed in 1896 we are not justified in stating at what time the disease first actually appeared. It may have been here only a few months previous to the general outbreak, or it may have existed much longer in a restricted locality, only waiting for a favorable opportunity to become widely disseminated.

To us, however, it is rather astonishing that the rust has not shown itself here long before this, as many of the other European fungous diseases have done. We know from the very earliest records that the greater majority of our troublesome weeds made their appearance in America at the time of the first settlement, and wherever the colonists wandered these old country weeds, which were so familiar to them at home, were among the first immigrants to meet them. And what would apply to weed seeds would seem to apply with greater force to the smaller and more numerous fungous spores. It is, indeed, difficult to understand why the enormous traffic existing between Europe and America at the present time is not the means of introducing every form of plant life that can possibly thrive in this country.

So far as our observations extend here in Massachusetts there appear, however, to be other causes of the rust, or at least the severe outbreak of it, which should be taken into consideration. We are of the opinion that the asparagus plants were in the most favorable condition during the summer of 1896 for a severe outbreak to occur. The seasons of 1895 and 1896 were exceedingly dry, so much so that the larger majority of plants adapted to dry soils were great sufferers, while the season of 1897 was equally abnormal for it was a season of excessive rains. After an inspection of the local-

ties where the summer stage of the rust appeared during 1897, and in fact these are the only places where the rust has done any harm although the fall stage during the same season was abundant everywhere, we found that in every instance the beds were confined to light sandy soil with little capacity for holding water. In every town where the soil was heavier and possessed more water-retaining property only the fall or injurious stage has been found. During the early part of the present season we became convinced that the severity of the rust was caused by the unhealthful conditions of the asparagus beds, a feature which appeared to us in almost every instance to be due to the enormous drain upon the plants, caused by the two excessively dry seasons of 1895 and 1896.

On the strength of these ideas and from the general appearance of the asparagus plants which we examined last summer, we repeatedly expressed the opinion to growers that there would be, in all probability, no summer stage of the rust that season, but that they might expect the fall stage. This prediction has been amply fulfilled, there being but one exception to it, as far as we have been able to learn, and that was where the summer stage appeared on a bed where the roots were all half dead from the effects of the rust in 1897, and which showed a loss of 80% in last spring's crop.

The fall stage of the rust has also been much less abundant than at any time since it was introduced. There are many beds only slightly affected at the present time, and some of those that we know were formerly subject to the fall stage have not a particle on them this year. There is a large bed upon the college grounds which has been badly infected with the fall stage of the rust ever since 1896, but which at the present time is almost entirely free from it. While we are convinced that the severe attack of the rust was due to excessive dryness, this may not have been in every case the sole cause of it, and it is not unlikely that the extremely abnormal rainy season of 1897 had something to do with aggravating the trouble.

Asparagus plants may become unhealthy from other causes such as would result from poor treatment, and in such cases they may become susceptible to rust. We do maintain, however, that perfectly vigorous plants are not likely to have the summer stage of the rust, or, in other words, to suffer from it, and our examinations of the asparagus beds in this state have convinced us of this. We have seen, too, many instances in connection with the rust, as with

other diseases, where infection is dependent upon the vigor of the plant.

Realizing that it would be well to get the idea of growers upon certain points, we addressed a number of circular letters to various parts of the State. Besides asking a number of questions in regard to differences of infection existing between moist and dry soil, etc., we incidentally referred to the dry seasons of 1895 and 1896 as being the cause of the outbreak. A quotation from one of these letters will suffice to show how these conclusions are regarded. Among other things the writer states "Yours of Nov. 16 received with pleasure and I feel that I have been enlightened much by its contents * * * * I feel confident that the asparagus rust was caused by dry weather." All of the data which we have been able to procure fully justify these conclusions.

Methods of Treating the Rust.'

At the present time little can be said in regard to a positive and practical method of controlling the rust during seasons of severe outbreak by means of spraying, although we are of the opinion that it can be kept in check by other methods. Some experiments have been made at different stations along the line of spraying, and the practice of burning has been resorted to by various growers.

BURNING THE AFFECTED TOPS.

The practice of burning the affected tops was recommended by Drs. Halsted and Sturgis, and also by ourselves, as a possible prevention from further infection. This method of treatment was based largely upon a knowledge of the general life history of rusts, as well as from the point of view of hygienic principles. The burning method, moreover, has been tried in Europe, or at least recommended, and as the rust is entirely new to this country we felt justified in adopting measures mentioned by those who have had the rust to deal with for many generations. We have only recommended the burning of infected plants late in the fall when they are thoroughly dead and dried out, as it appeared to us by so doing we would destroy millions of the spores and lessen the chance of infection next year. It must, nevertheless, be said that we have never observed the slightest benefit from burning the infected tops at any

season of the year, but, on the other hand, we have had cases brought to our attention where the tops were cut and burned in August, which resulted not only in a useless expenditure of labor, but in a decided injury to the plants. It has been found that if a crop of asparagus tops is cut down in mid-summer a new crop will take its place, and the latter will in the course of a few days be as badly affected as the first. In this instance we not only get two crops of infected tops where we would naturally get only one, but we allow the plant to draw upon its reserve material to a degree that is quite unnecessary, and sure to make itself felt in the succeeding crop. The burning of the tops in the summer is, moreover, not an easy task, inasmuch as they are laden with sap and do not show a tendency to dry out readily. The asparagus growers in some parts of the state who have tried the burning method in summer are not at all pleased with it, and we are convinced that their judgment upon this practice is sound.

SPRAYING.

The most extensive experiments reported as yet on the spraying of asparagus for the rust, are those by Professor Halsted, in New Jersey. He experimented with the standard Bordeaux mixture, and also with the same solution in combination with soda, potash, etc. His best results showed only a difference of about 25% between the treated and untreated plants, or in other words, a gain of this amount as a result of spraying. Without following these experiments any further it must be admitted that the small gain obtained by spraying is not encouraging.

Some experiments in spraying were conducted by ourselves, the past summer, at three different places, and the result in each series was negative. One of the experiments was made in connection with Wilfred Wheeler, at Concord. Two rows of asparagus were sprayed with each of the following solutions, and two rows were left in between the sprayed ones as normals or checks for comparison. The solutions used were Potassium permanganate, Potassium sulfid, Saccharate of Lime, and Bordeaux mixture. Four applications were made in all. The first one was in July before any rust had appeared, and it was continued throughout August. An examination and comparison of the sprayed and unsprayed plants in September showed them to be equally infected with teleutospores (the uredospores did not appear), although it appeared as if there was a lit-

tle less upon the Potassium sulfid rows. The two other series of experiments tried gave no better results. The spraying was done with a knap-sack sprayer, provided with a Vermorel nozzle, and after the first application we became convinced that the practice was of little importance on account of the difficulty in making the solution stick to the plant. For successful spraying of asparagus a finer nozzle is required than any that is now in the market. In some other experiments carried out on a small scale we succeeded in practically covering the asparagus plants with solutions, when they were put on with an ordinary cylinder atomizer, and the lime solutions showed excellent sticking qualities, but with the ordinary coarse nozzle the solutions would run off of the glossy epidermal covering of the plant very readily.

Should the spraying of asparagus ever become a necessity as a means of preventing the rust, which we greatly question, then some apparatus which can be strapped to a horse's back should be used. The narrow space between the rows forbids the use of the ordinary mounted appliances, and if spraying is to be carried on upon a large scale it would be better to have the spraying mixture carried in some manner on the horse's back. In this way it would be possible to carry some thirty or forty gallons of mixture through the narrow rows. In conclusion it must be confessed that experiments along the line of spraying are not encouraging, for the reason that the asparagus plant is a difficult one to reach as well as to cover thoroughly with ordinary solutions applied with the present style of nozzle.

CULTIVATION AND IRRIGATION AS A MEANS OF CONTROLLING THE RUST.

From what has been said in regard to the practice of burning the affected asparagus tops and the unsatisfactory results which have been obtained from spraying, it would not be out of place here to pay some attention to other methods of control. Even should the practice of spraying give promise of better results, it would not be a method which would satisfy the best growers. Spraying crops to control diseases is not the sole end of gardening, and the most that can be said of the practice, in many cases, is that it is only tentative. Any one who has had an opportunity to examine the crops of the most successful gardeners, such as have been handled by specialists for years, knows that they do prevent diseases

merely by a correct system of cultivation, while crops from the same stock in the hands of a novice are too often a sorry sight to behold. We have already pointed out that the injury to asparagus plants, as a result of rust, has been confined to dry soils, although there are cases where beds in close proximity showed remarkable differences as to infection. We have observed two beds separated from each other by a distance not exceeding ten feet, where in one case the summer stage of the rust was abundant and greatly reduced the bed, while in the other no rust was present except the fall stage. The soil in both beds was apparently the same, at least so far as superficial observation could determine, but the plants were of a different age and evidently possessed differences as to vigor. Similar conditions could be observed in all the badly infected regions in 1897, and even in the single instance where the red rust appeared the past summer the other beds in the vicinity, notwithstanding the fact that they were continually subject to infection, never showed any of the rust till late in the fall. The only deduction to be drawn from such facts is that robust and vigorous plants, even when cultivated on apparently dry soil, are capable, as it were, of resisting the summer or injurious stage of the rust.

Most asparagus growers, as a rule, fertilize their crop abundantly with various commercial fertilizers. We have never, however, been able to observe any particular ill effect from the kinds in use, although it might be more advantageous, in extremely dry places, to use fertilizers containing considerable amounts of organic matter, in order to give the soil more water-retaining properties. In a season of excessive dryness such as 1895 and 1896, irrigation could in many instances which we have observed be resorted to with very little expense. This would keep the plants in a normal and vigorous condition during such seasons, and had this practice been resorted to twice or three times in 1895 and 1896 the summer or injurious stage of the rust would have been held in check. The severe outbreak in 1897 we consider as sporadic in its nature, and we are of the opinion that there will be very little occurrence of this disease, except during seasons of extreme conditions, which occur generally at intervals of some years. With proper plant food and good cultivation, and without the plants being subject to extreme conditions, there is no reason in our judgment why the asparagus rust need give us any concern.

The Asparagus Rust in Europe.

That the rust has long been known in Europe is apparent from the fact that it was first described there, although, like many other of our worst pests of the field and garden, it appears to have never become so troublesome in the Old World as with us. The disease is described in most of the German and English books on plant diseases, but we have been told by several well known German botanists that it has no practical importance with them, occurring only rarely and not at all extensively. Certainly no such general epidemic of the disease as has recently occurred in this country ever appeared in Europe.

A Natural Enemy of the Rust.

Another parasitic fungus has been observed in many cases in connection with the summer and fall stage of the rust, which does not, however, attack the asparagus plant but lives upon the rust fungus itself. It is therefore beneficial rather than harmful, since it must act to a greater or less extent as a check upon the development and spread of the disease. This fungus is one called *Darluca Filum Cast.* It consists of filaments which grow in amongst those of the rust and develop in the pustules of rust spores little black conceptacles in which the spores of the parasite are produced. These spores are somewhat smaller than those of the rust and ooze out upon the surface of the rust spots in great quantities, giving them a mouldy appearance. We found this parasite especially abundant upon the summer stage of the rust in 1897, as well as upon the fall stage both this year and last. Halsted (*loc. cit.*) and Johnson* have also reported its occurrence and it could no doubt be found wherever the rust has appeared. It is interesting to note that we have also found the same parasite upon specimens of the rust from Roumania, where the asparagus plant is said to grow wild. It is possible that this is at least one of the agencies which have prevented any extensive development of the rust in Europe.

Halsted (*loc. cit.*) also describes another parasite, *Tubercularia persicina* Ditt., which he has observed upon the spring form of the asparagus rust. We have found several other fungi upon asparagus plants, but they were mostly such as had already been weakened by the rust and we do not consider these as diseases of any practical importance. What appears to be the "leopard spot" disease

*Bull. 50, Maryland Agri'l Experiment Station.

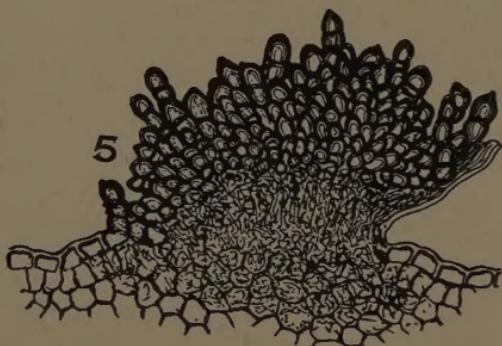
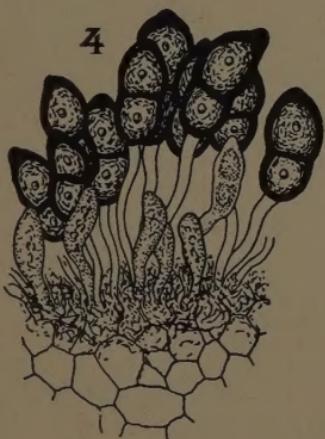
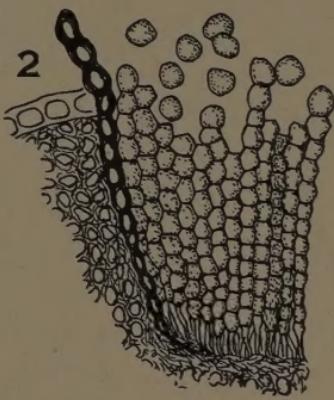


PLATE II.

